RADARSAT-2 Program Update

20 September 2007

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CSA-MDA Public-Private Partnership

Objectives

- **Provide SAR data continuity from RADARSAT-1**
- **Meet user needs for new applications opportunities**
- **Maintain Canada's position in the commercialization, utilization and development of advanced operational SAR capabilities**

Roles

MDA-GSI

- Design Authority
- Will own and operate RADARSAT-2
- MDA-GSI will sell and distribute RADARSAT-2 SAR imagery worldwide

CSA

- Technical expertise and Interface with other Canadian Government Departments
- CSA's contribution will allow access to the SAR imagery required by the Canadian Government User Departments

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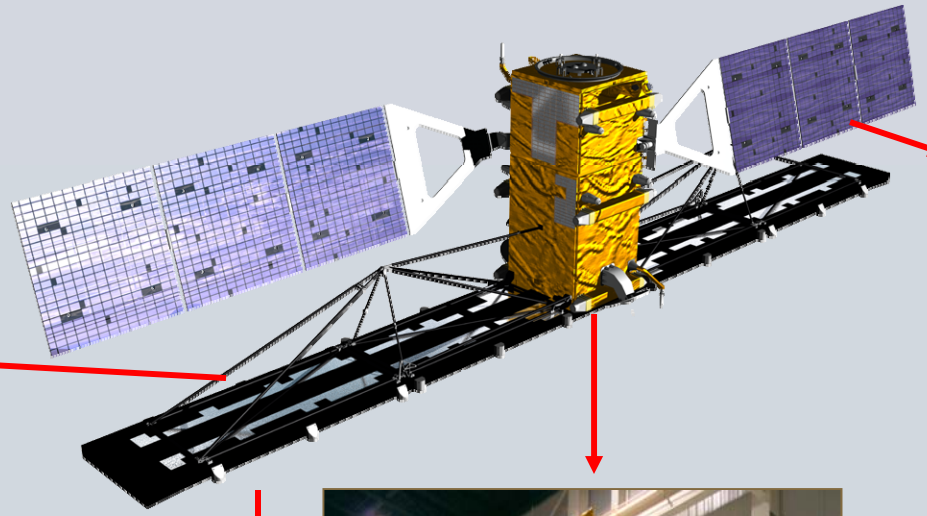
Spacecraft



ABLE Engineering a PSI Company

Extensible Support Structure (ESS)

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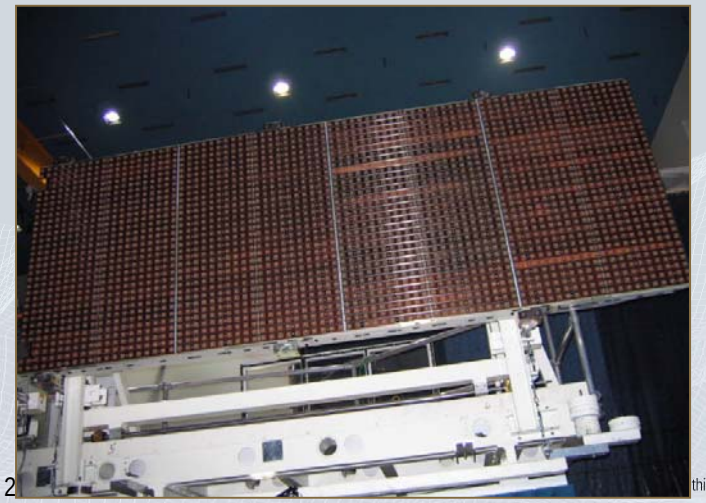
SAR Antenna and Sensor Electronics



Alenia AEROSPAZIO Divisione Spazio

Bus and Solar Arrays

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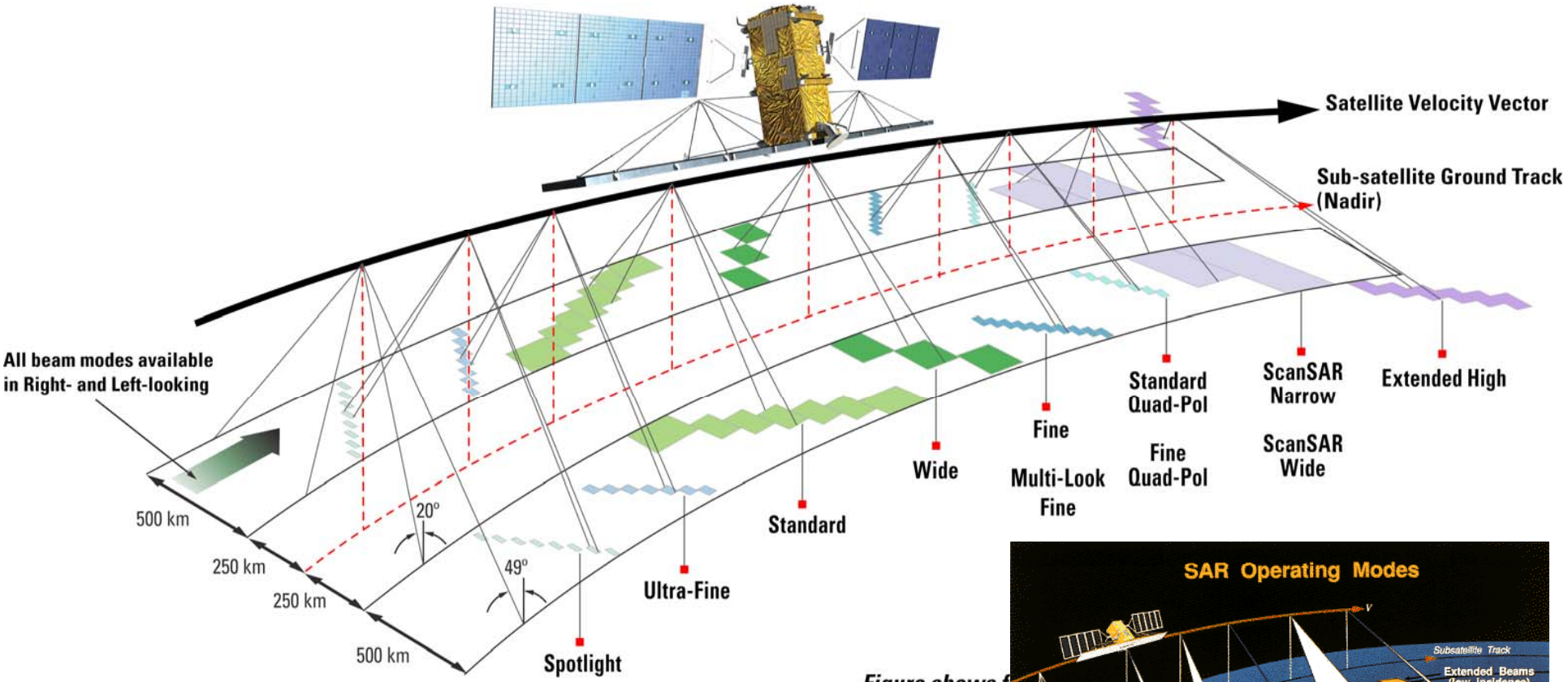
RADARSAT-2 Imaging Modes



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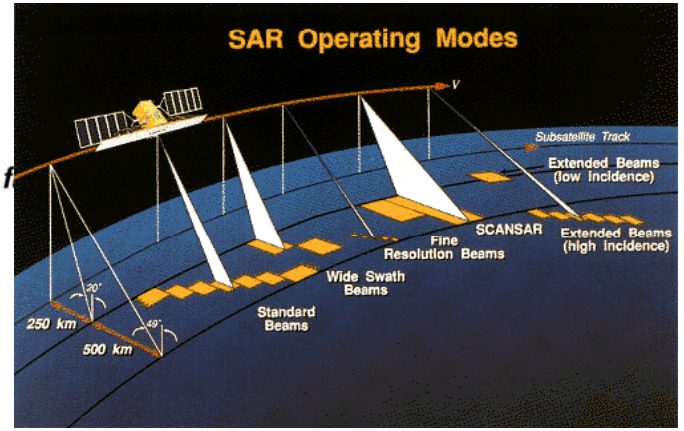
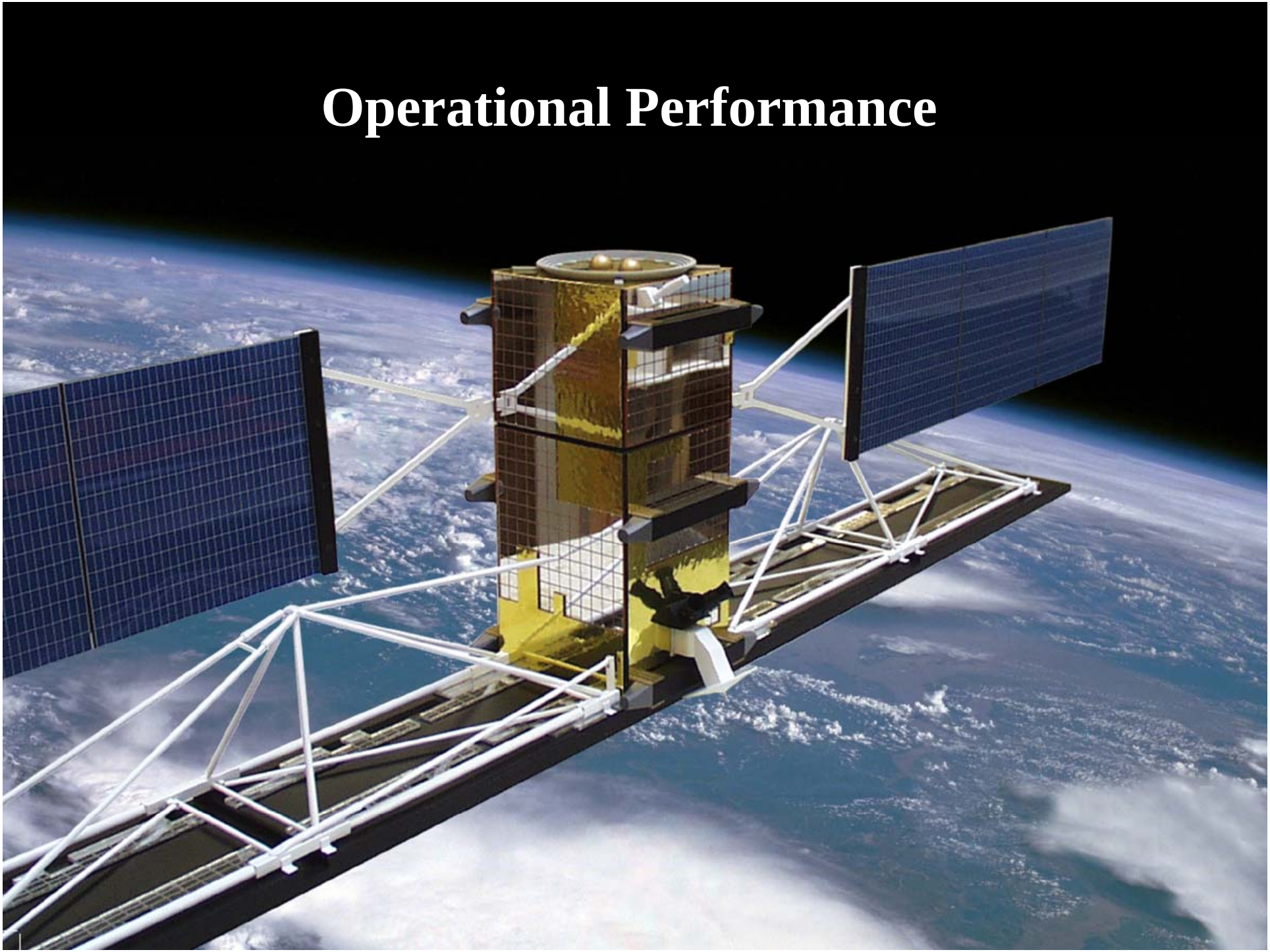


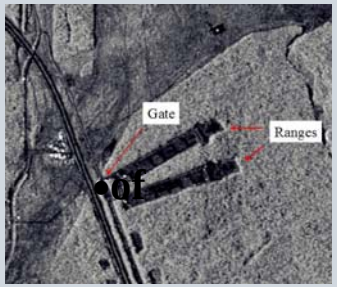
Operational Performance



RADARSAT-2 Daily Volume of Data

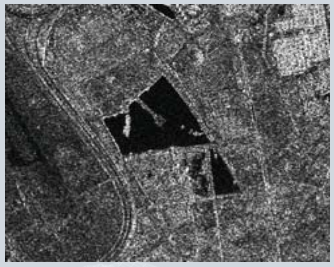
The spacecraft can provide as much as 315 minutes of imaging time each day. Therefore, enough image data could be acquired and downloaded in a single day to support all the following tasks:

- Acquire 320,000 sq. km. UltraFine beam (3-meter resolution) imagery in support of targeting



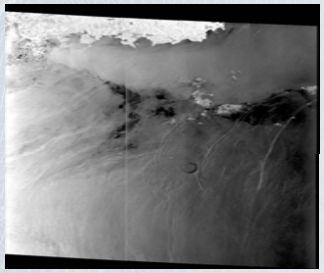
An area equivalent to the size of the state of New Mexico

- Acquire 9,100,000 sq. km. of Wide beam (25-meter resolution) imagery in support of wide area surveillance



An area equivalent to the size of the United States of America

- Acquire 25,000,000 sq. km. Of ScanSAR (100-meter resolution) imagery in support of ocean surveillance



An area equivalent to 25% the size of the Atlantic Ocean

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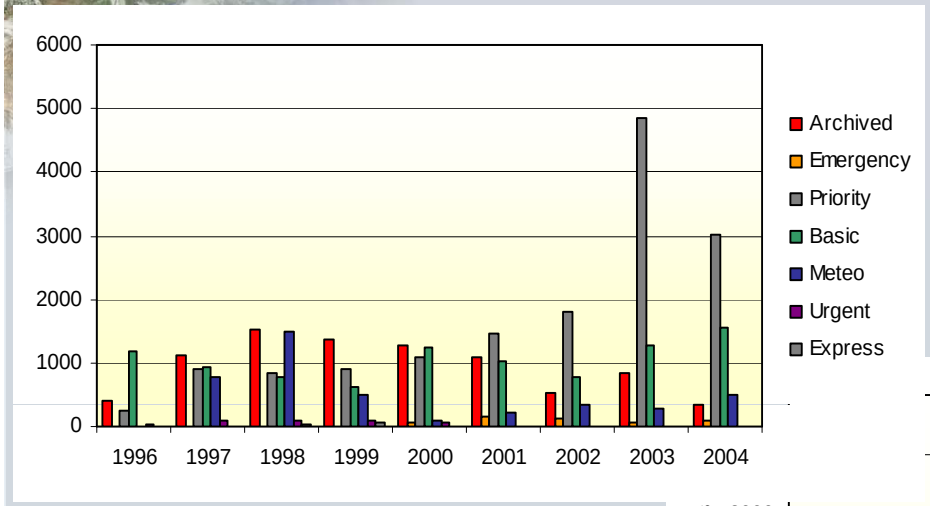
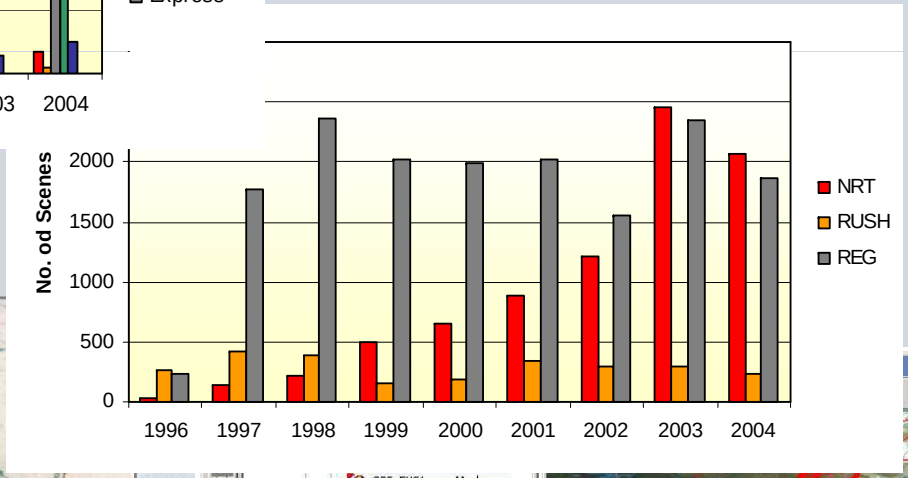
Planning & Delivery Timelines

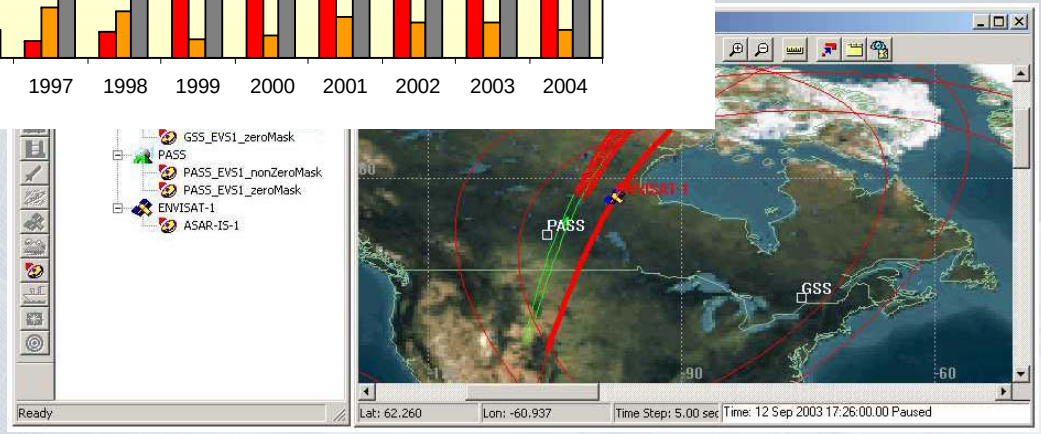


Planning

- RADARSAT 1 experiences shows increasing demand for rapid planning and data delivery
- New planning tools and procedures reduce planning lead time to 12 hours (routine) and 3 hours (emergency)
- Near real time delivery target is 15 minutes

Processing





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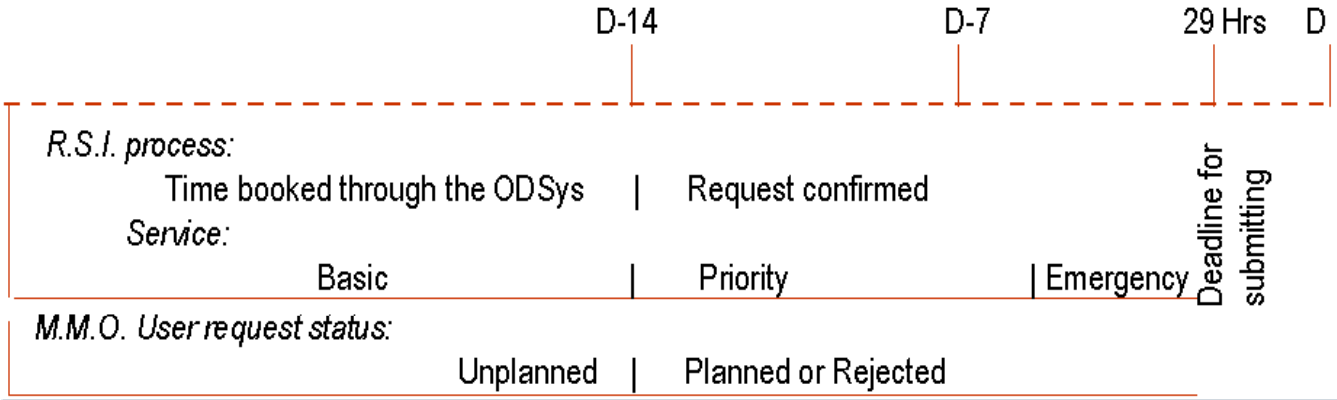
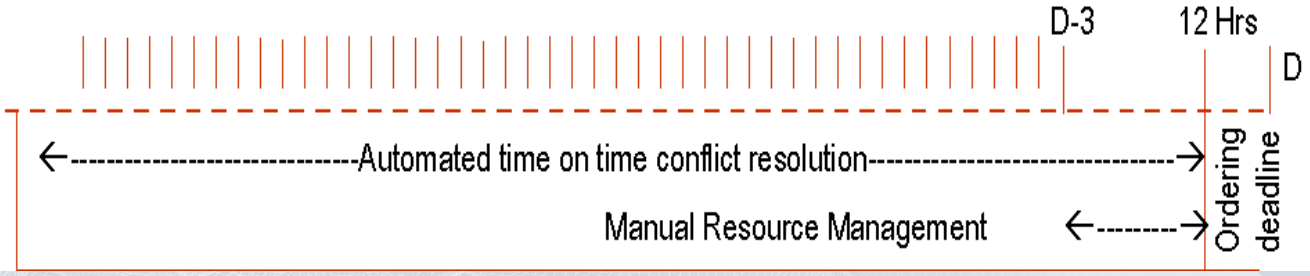
Improved Planning, Ordering and Tasking Timelines

RADARSAT-1



RADARSAT-2



Before D-3 Commit Time:

- **Higher priority requests bump lower priority**
- **Requests of equal priority are first come first served**

After D-3 Commit time

- **New requests on best effort basis**
- **All planned requests are protected except for emergencies**

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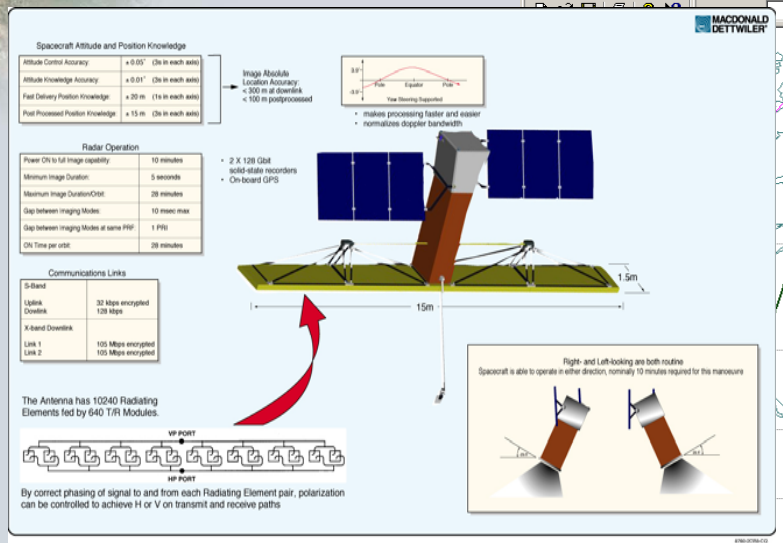
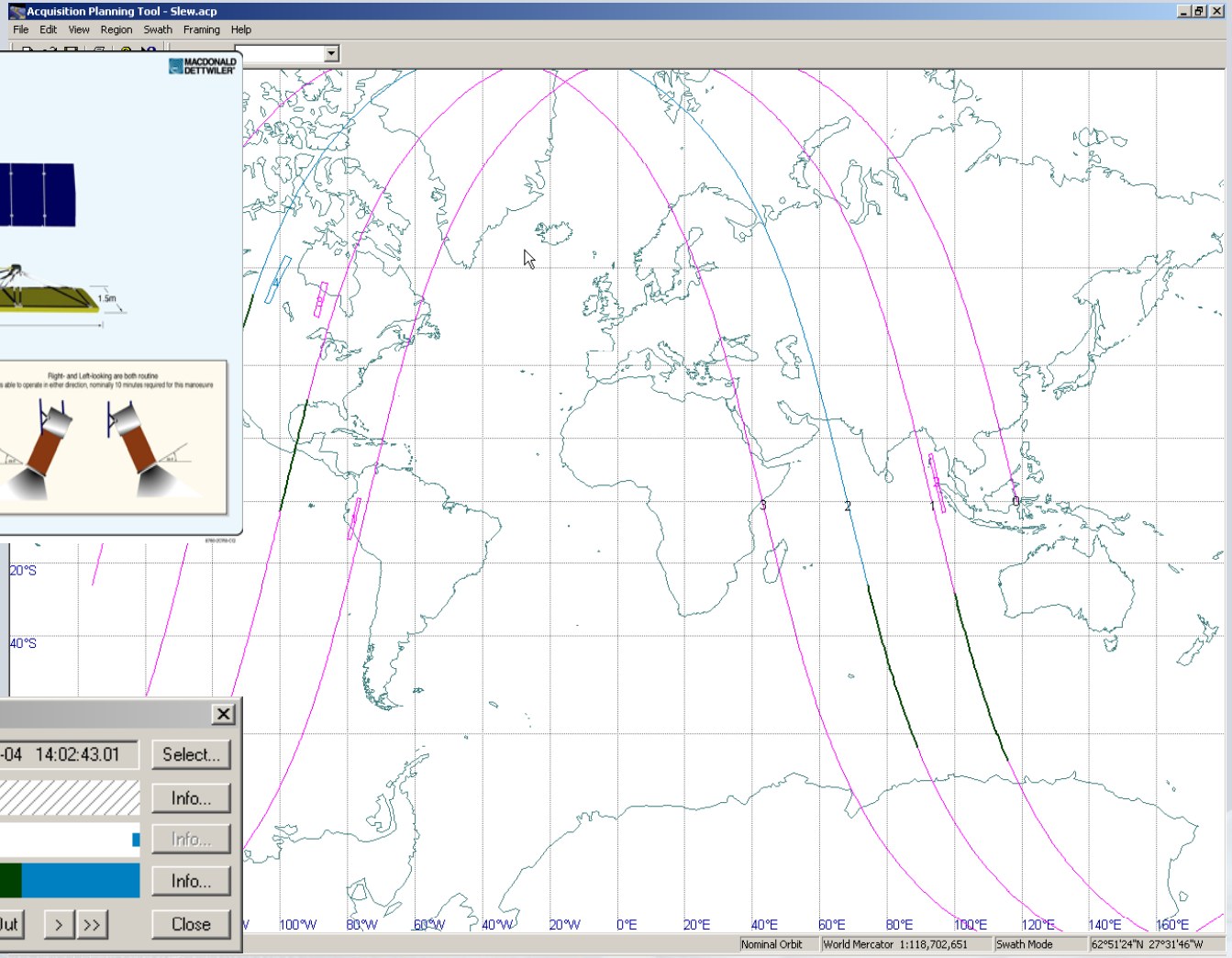
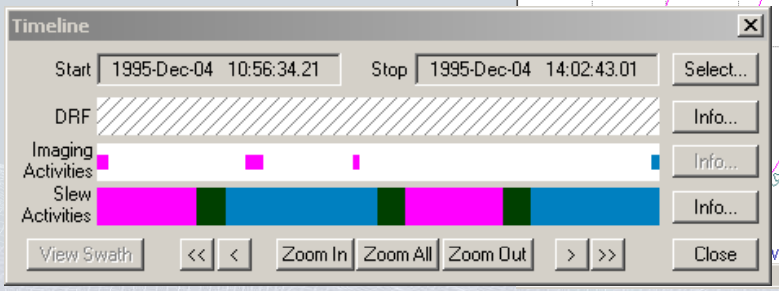
Slew Plan Visualisation







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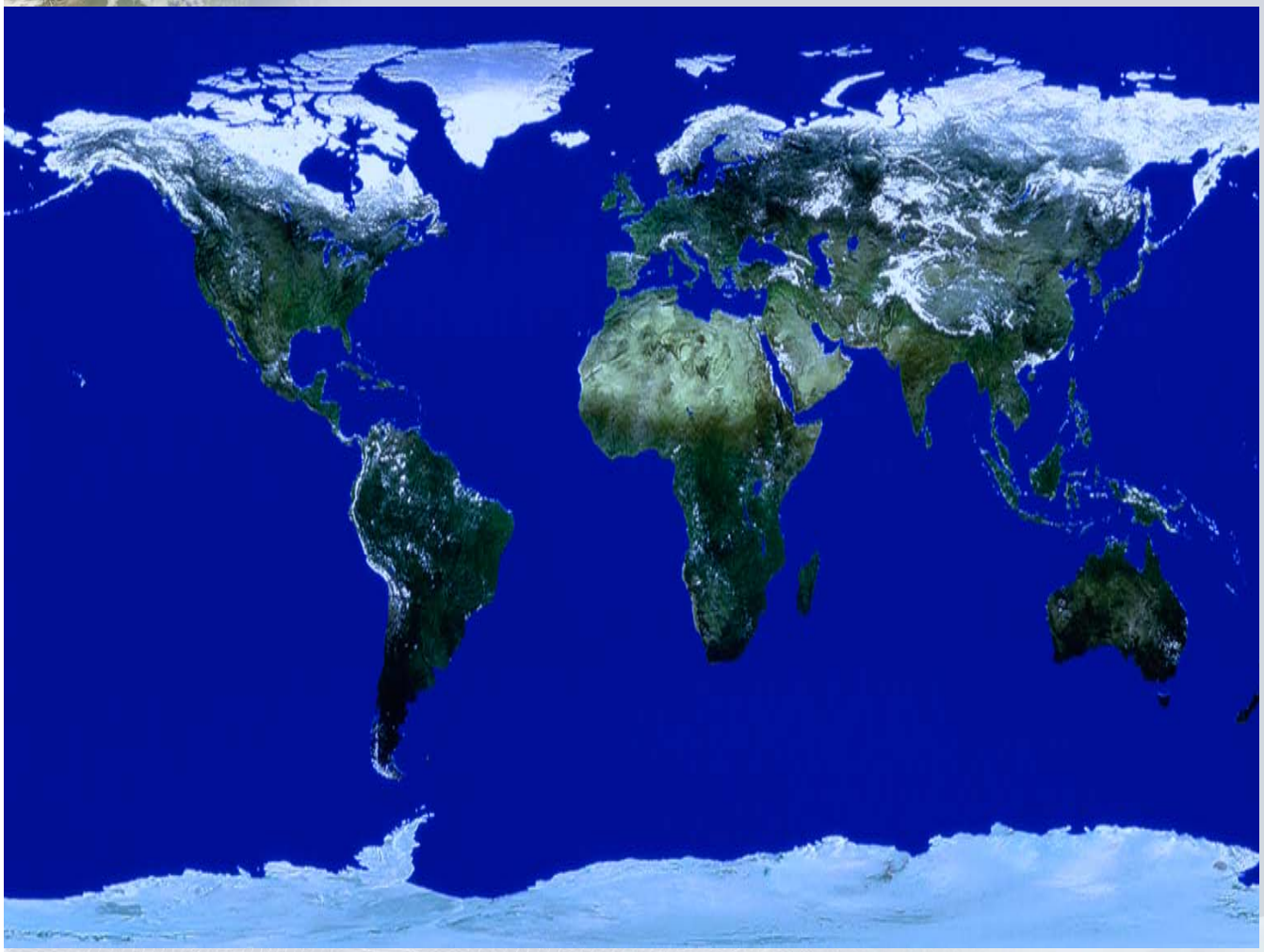
Global Data Access via Solid State Recorder



- The SSR allows images to be acquired anywhere throughout the orbit & randomly selected for downlinking
- Solid-state recorders have a memory of 305 Gbits (EOL) and addressable data retrieval

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Product Format and Specifications

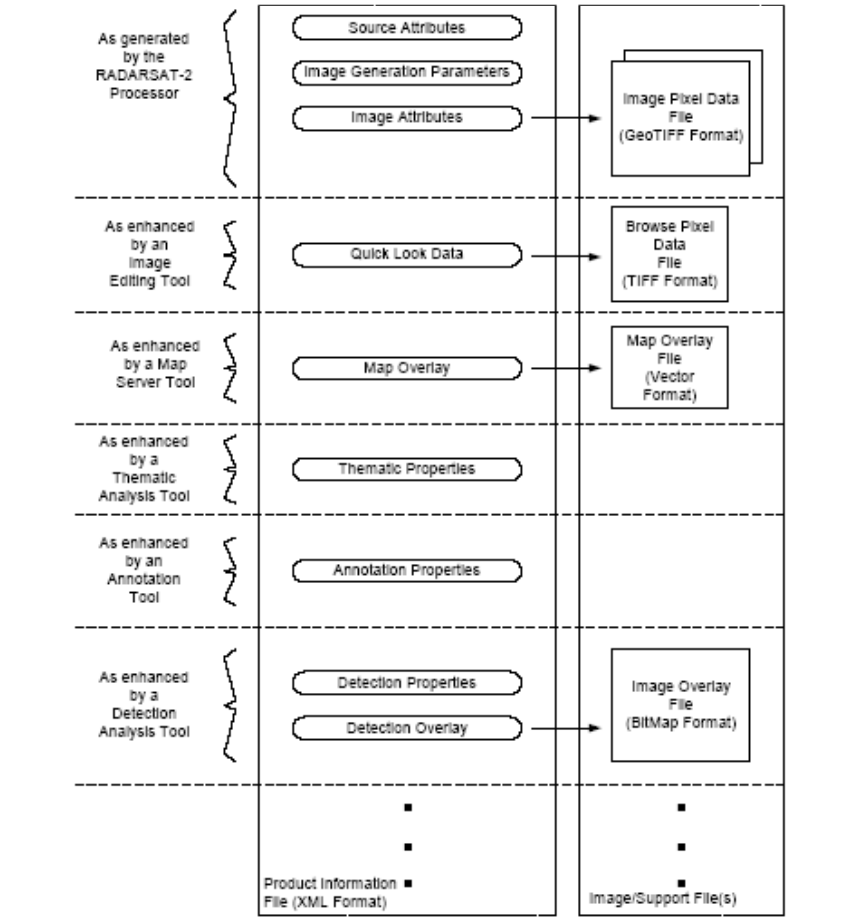

Figure 3-1 Product Format Concept

- Image product will be delivered as GeoTIFF
- The Meta-Data file will follow Extensible Markup Language (XML) format, which is widely used for database and computer communication applications.
- RAW data will be archived in FRED format

Available online:

- http://www.radarsat2.info/application/51-2713-RSAT-2%20ProductFormatDefinition-Iss1_5.pdf

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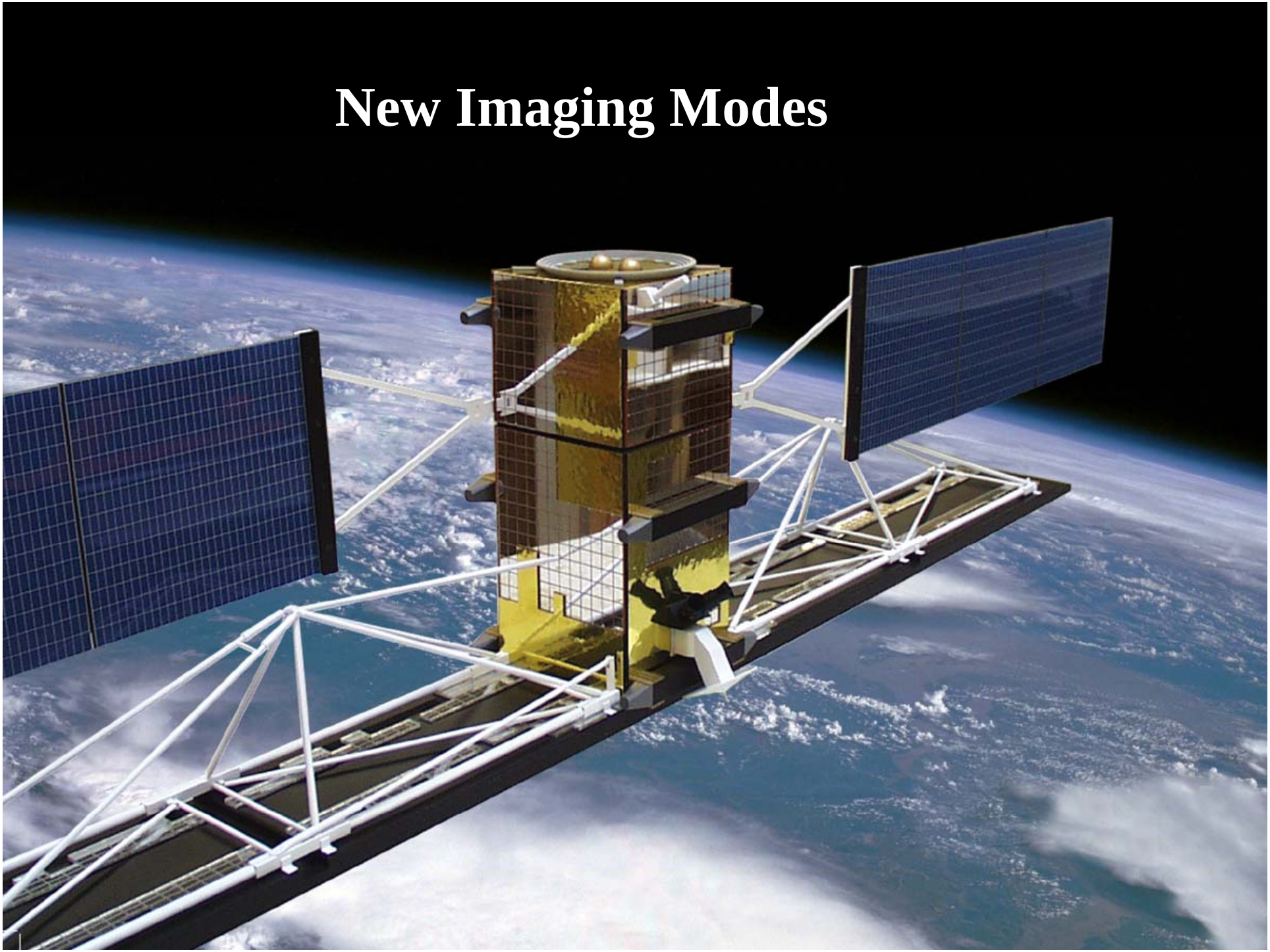
New Imaging Modes

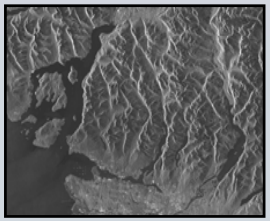


RADARSAT-2 Polarization Diversity

RADARSAT-2 supports a variety of polarization modes that dramatically increase per pixel information content

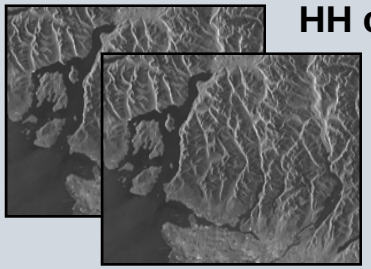
Multipolarization:

Selective Single Polarization
- -22 dB NESZ (nominal)



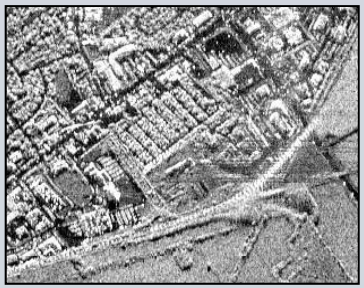
HH or VV or HV

Selective Dual Polarization
- -23 dB NESZ (nominal)



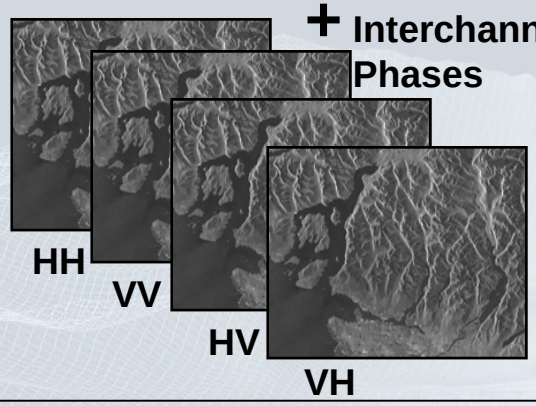
HH or VV

HV or VH



Will enable better discrimination and recognition of objects on the ground and improved classification capability--complementing high-res optical sensors

Polarimetry
- -30 dB NESZ (nominal)
- relative phase error 5°



Provides for unsupervised classification and for much stronger inferences on

(1) target identification,

(2) change detection, and

(3) land cover type (surface moisture, roughness, vegetation cover)

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Beam Mode Ratios

Table 3-1: RADARSAT-2 Beam Mode Characteristics

Beam Mode Type	Operating Mode	Polarization Options	Elevation Angles	Incidence Angles	Noise-Equivalent Sigma-Zero	Ground Resolution (Rng x Az) (m)	# of Looks Range X Azimuth (grnd.rng. prod)	Swath Width	Max Acquisition Area Per Orbit (sq km)
Spotlight	Spotlight	HH or VV	26°-47°	30°-55°	-21±4 dB	**2.0-3.3 x 0.8**	1x1	**20 km**	21170
Standard Quad-Pol	Polarimetric Stripmap	HH+HH + VV+VH	18°-36°	20°-41°	-31±2 dB	**22.3-28.6 x 7.9**	1x1	**25 km**	177500
Fine Quad-Pol	Polarimetric Stripmap	HH+HH + VV+VH	18°-36°	20°-41°	-28±2 dB	**8.4-16.0 x 7.9**	1x1	**25 km**	177500
UltraFine	Dual-Receive Stripmap	HH or HV or VV or VH	26°-43°	30°-40°	-21±2 dB	**2.5-3.4 x 3.0**	1x1	**20 km**	115400
Multi-Look Fine	Dual-Receive Stripmap	HH or HV or VV or VH	26°-43°	30°-50°	-20±2 dB	**7.4-9.1 x 7.9**	2x2	**50 km**	419700
ScanSAR Wide	ScanSAR	HH+HV or VV+VH	18°-42°	20°-49°	-23±2 dB	**82-183 x 90-113**	4x2	**500 km**	5628000
ScanSAR Narrow	ScanSAR	HH+HV or VV+VH	18°-40°	20°-46°	-23±2 dB	**43-91 x 46-77**	2x2	**300 km**	3376800
Standard	Stripmap	HH+HV or VV+VH	18°-42°	20°-49°	-24±2 dB	**19.2-29.2 x 25.6**	1x4	**100 km**	1125600

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Image Comparison

- Fine
- Multi Fine
- Ultra Fine
- Spotlight

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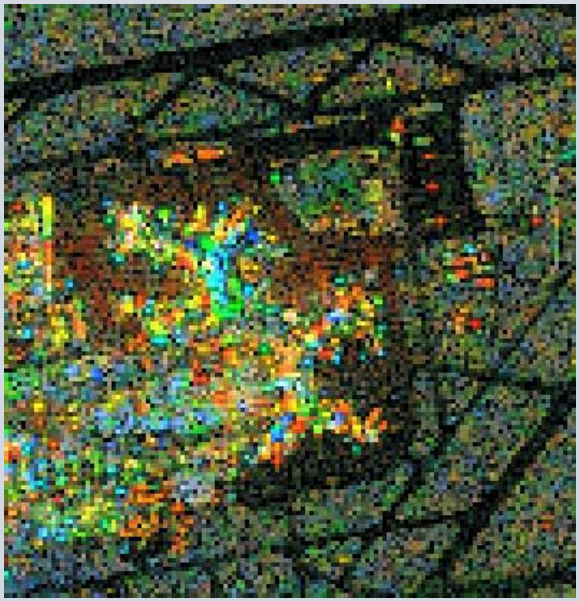
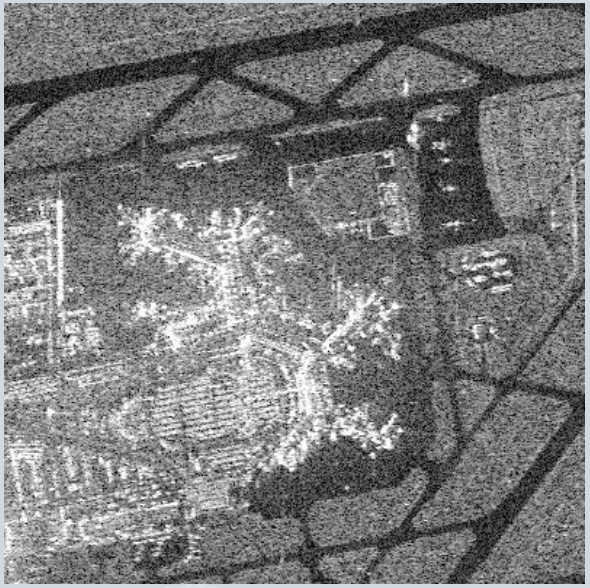
Data Fusion: Polarimetric and Higher Resolution Single-pol Data

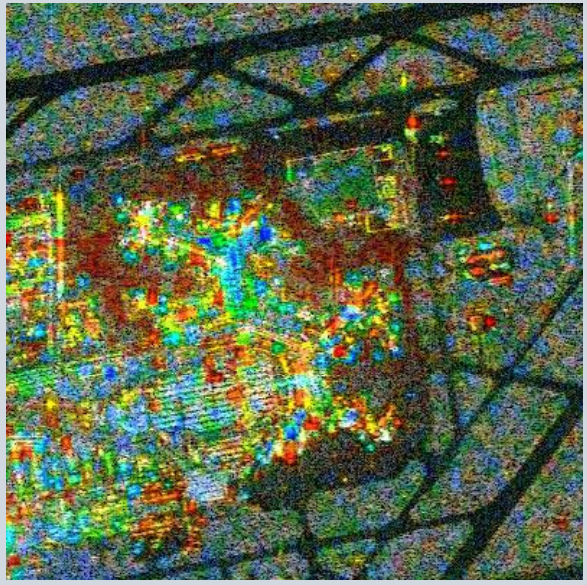
Interpretation of polarimetric data and polarimetric change detection will benefit from fusion with higher resolution single-polarization data



RADARSAT-2 Quad-Fine polarimetric image (~9m resolution, α-angle representation)



RADARSAT-2 Ultra-Fine single-polarization image (~3m resolution, HH)



Result of sharpening polarimetric data with higher resolution image

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RADARSAT-2 Customised Imaging Modes

The re-configurable design of the RADARSAT-2 payload permits programming of new imaging modes tailored to customers requirements.

- Re-configurable parameters
  - Resolution
  - Incidence angle
  - Polarization
  - Swath width
- New imaging modes are subject to power, noise level and data rate constraints

- Possible example additions to RADARSAT-2 standard offering:
  - Higher resolution polarimetric mode (reduced coverage)
  - Hybrid look-ahead, look-behind modes (ultrafine + polarimetric?)

- The capability to re-configure has major implications on maintaining critical performance as the system ages

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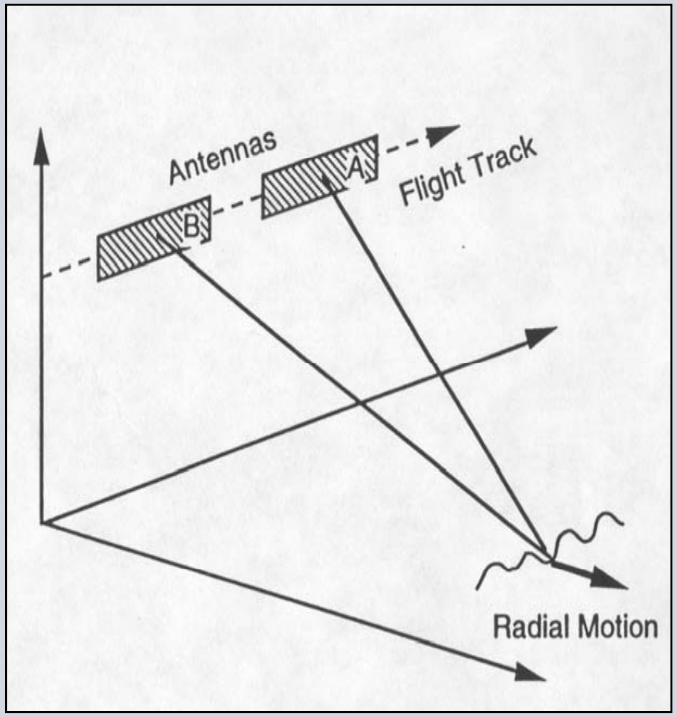
Advance Modes
Moving Object Detection Experiment (MODEX)

- MODEX has been implemented as an experimental mode
- MODEX is essentially Along Track Interferometry (ATI) which provides measurements of the radial velocity of targets
- Applications:
  - vehicles/ships: studies indicate a minimum detectable speed of ~ 5 m/s
  - ocean currents: analysis suggests that speeds to 0.25 m/s at 100 m resolution cells can be obtained



Split-antenna ATI concept

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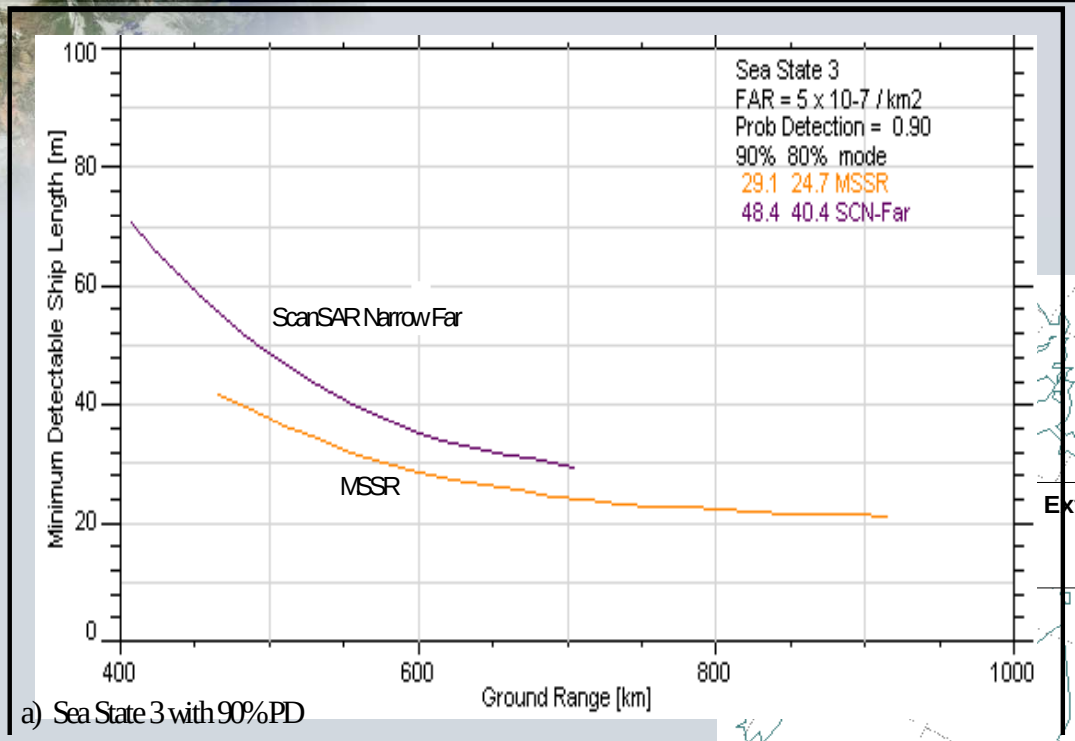
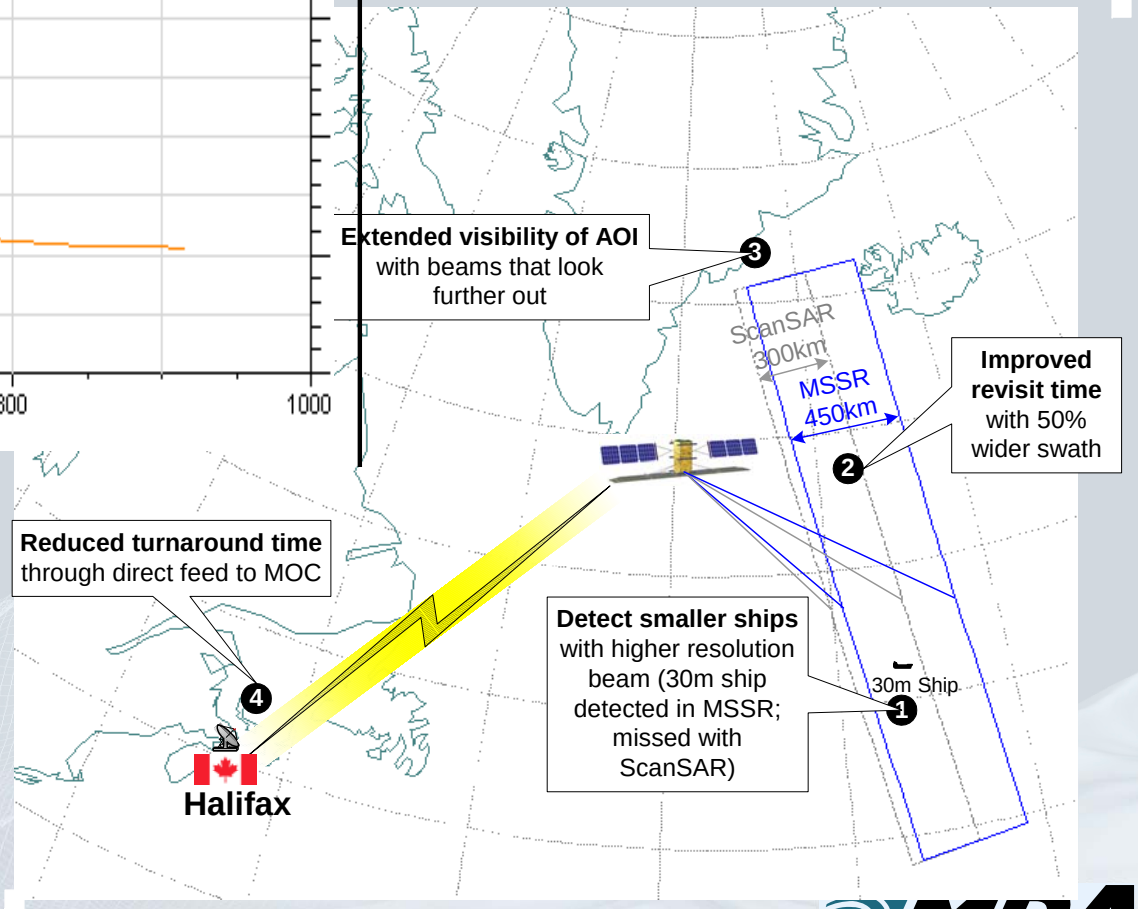
MSSR Concept



a) Sea State 3 with 90% PD

- **MSSR concept improves target detection while retaining wide area coverage**



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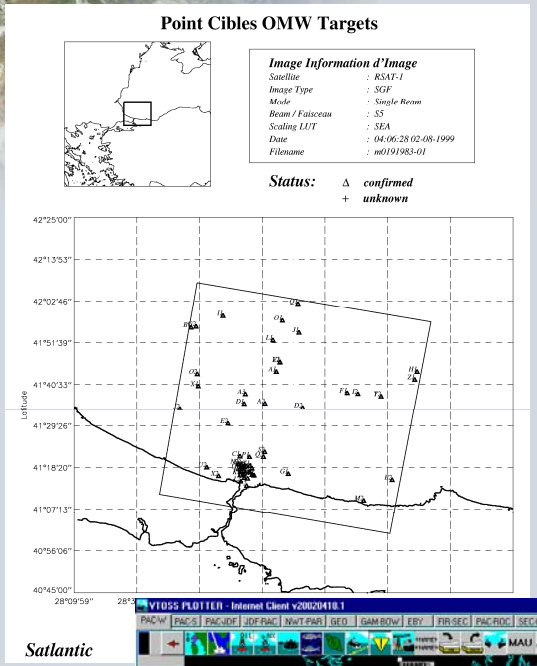
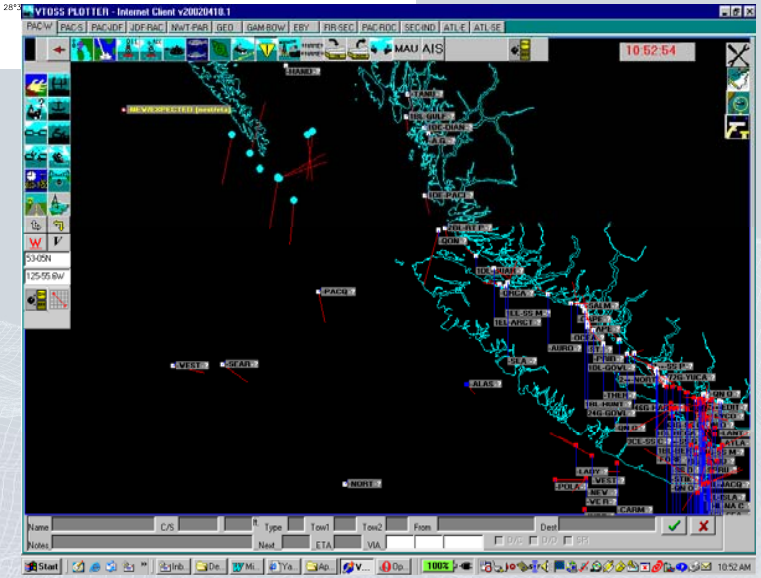
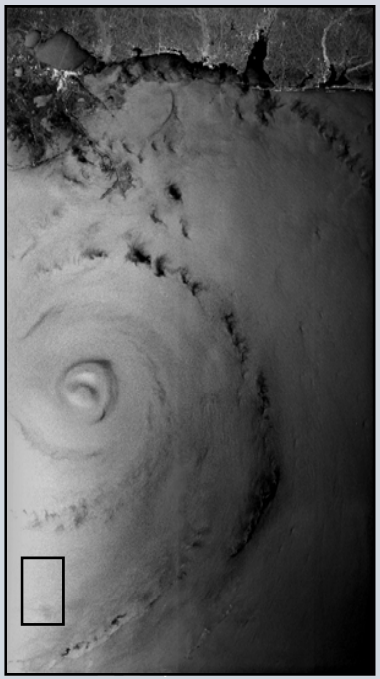
Maritime Surveillance



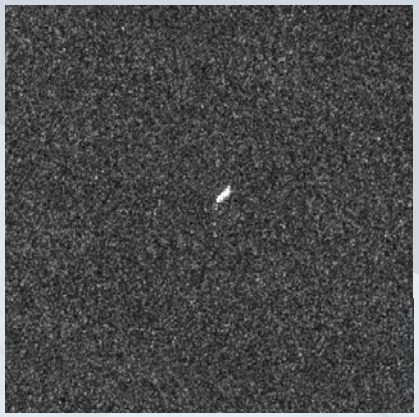


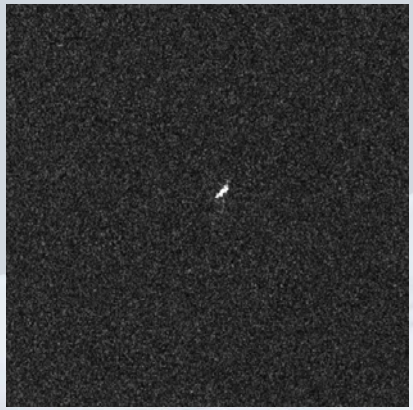
Key Improvements

- Tasking & delivery enhancements
- Multi Polarized data
- Improved geolocation accuracy
- MSSR mode



HH





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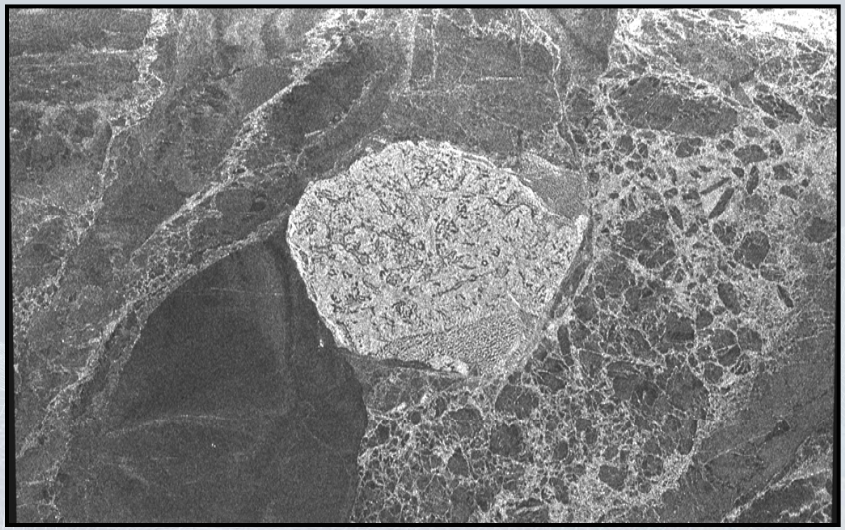
Ice Monitoring

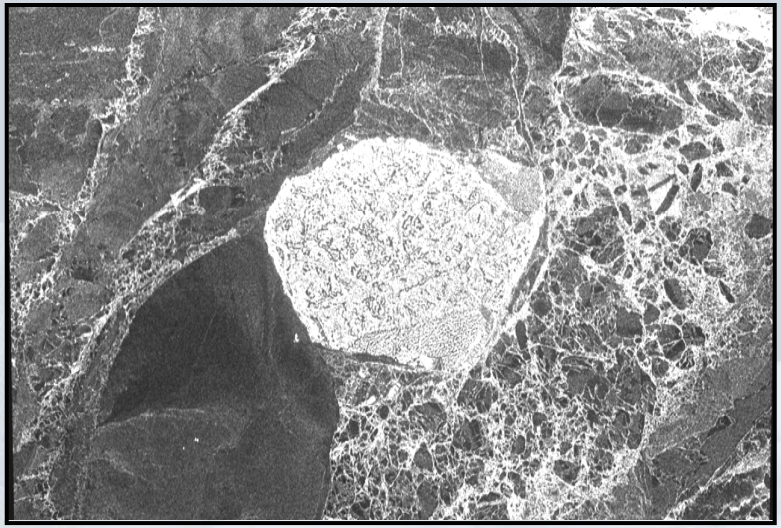
Key Improvements

- Tasking & delivery enhancements
- Multi Polarized data
- Improved geolocation accuracy
- MSSR

HH



HV



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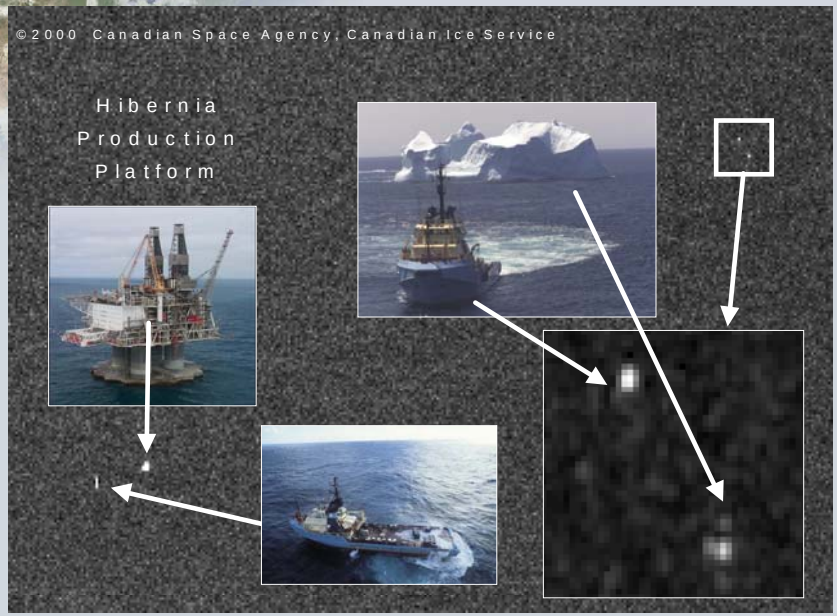
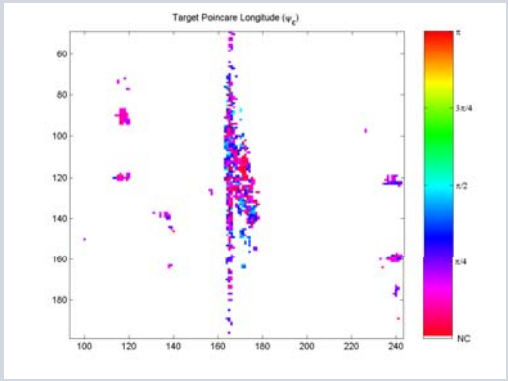
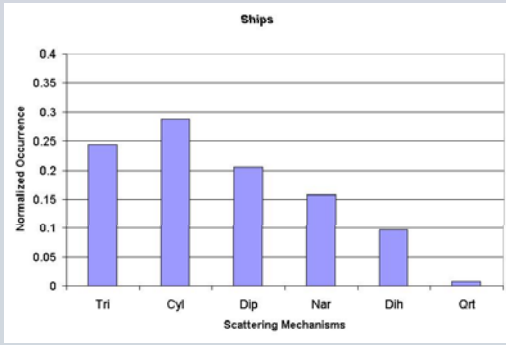
Maritime Surveillance: Polarimetric Marine Target Analysis

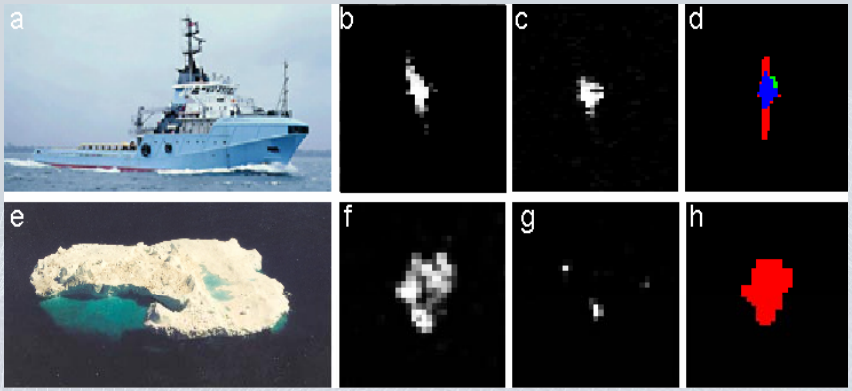


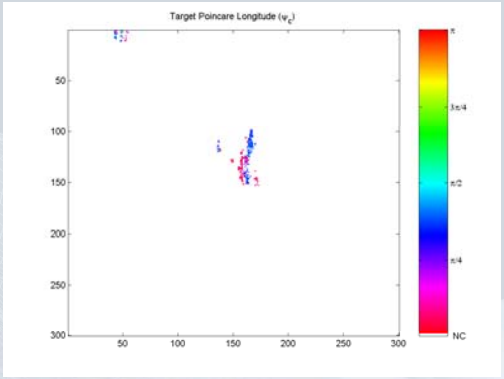
Ship Dominant Scattering Mechanism
Trihedral, Cylinder, <u>Dipole</u>

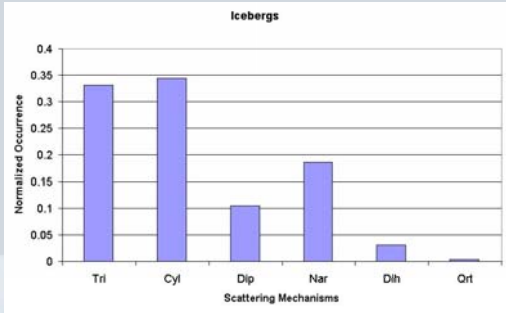




Iceberg Dominant Scattering Mechanism
Trihedral, Cylinder







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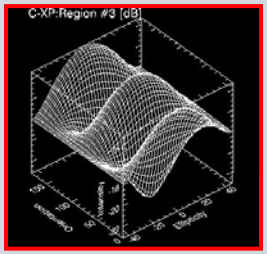
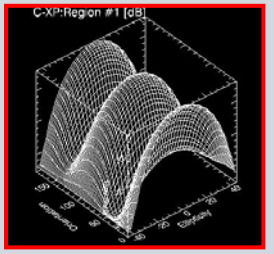
MDA™

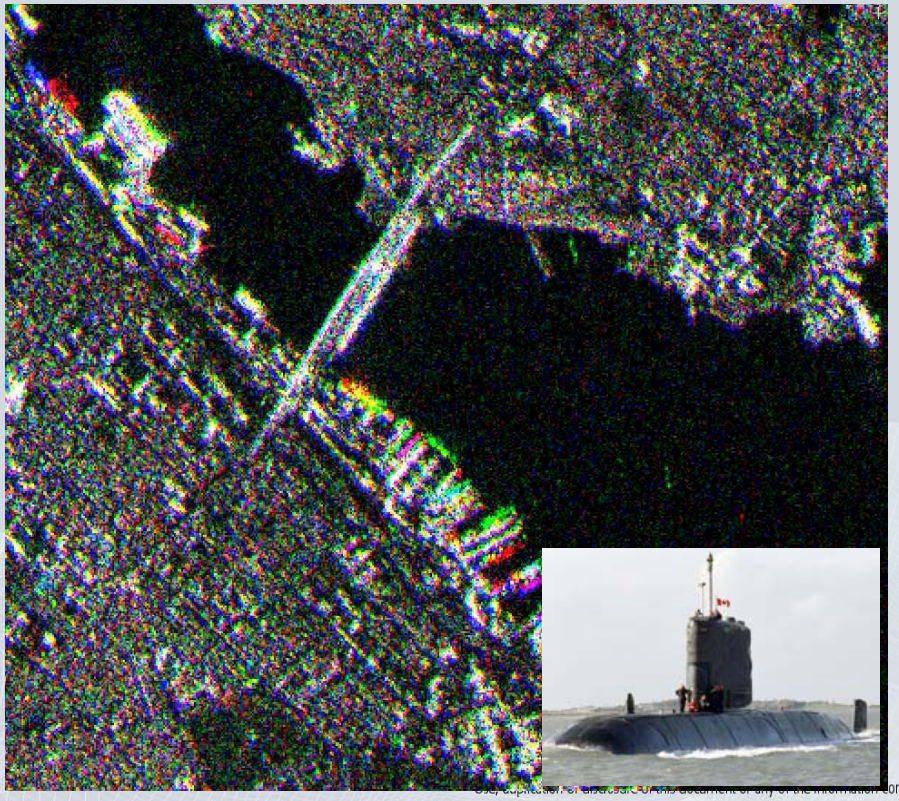
Defence

Key Improvements

- Higher spatial resolution
- Polarimetric capability
- Tasking & delivery enhancements







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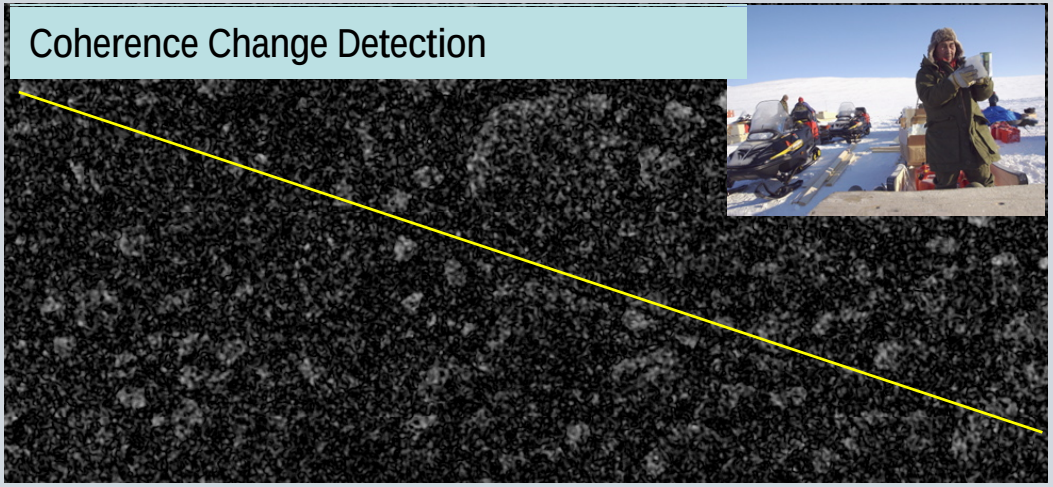
INSAR Techniques

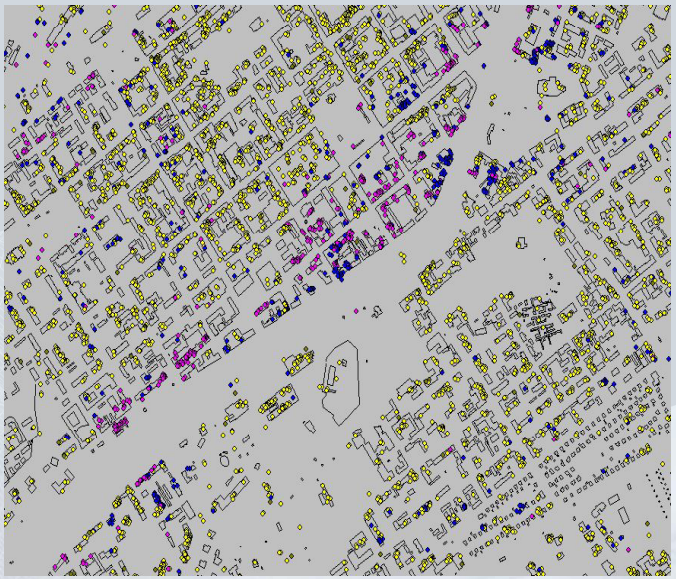
Key Improvements

- Orbit knowledge and control of RADARSAT-2.
- High resolution data
- Multi Polarized data
  - Polarimetry may shorten the time required to acquire a reliable PSINSAR stack, for RADARSAT-1 this is currently 1-year (15 images).
  - Polarimetry provides additional tools for testing the stability of and classifying persistent scatterers

Coherence Change Detection



Subsidence



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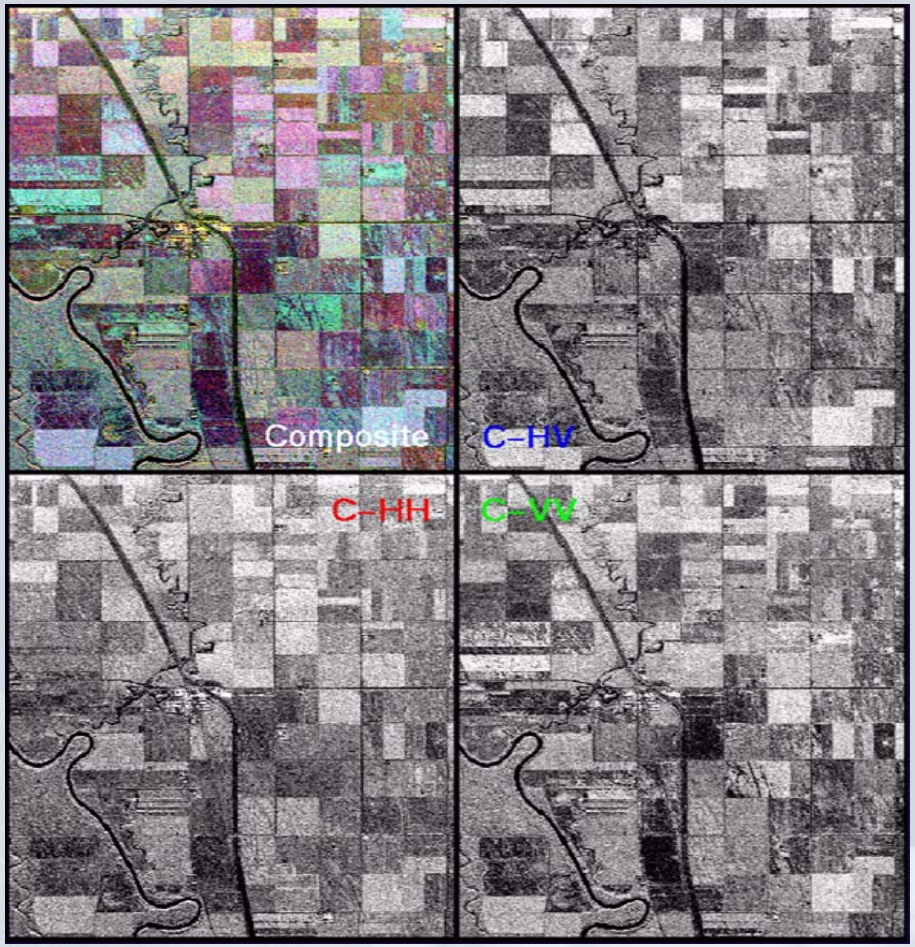
MDA™

Agriculture

Key Improvements

- Multi Polarized data
- Polarimetry
- Higher spatial resolution



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Bus Delivery

Testing

SAR Integration

System Level Test

Solar Array Integration

Environment Testing

Appendage Deployments

Final Integrated System Test

Operations Validation

Pack & Ship to Launch Site

Launch

S/C Operational

- Bus Delivery
- **Testing**
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- System Level Test
- Solar Array Integration
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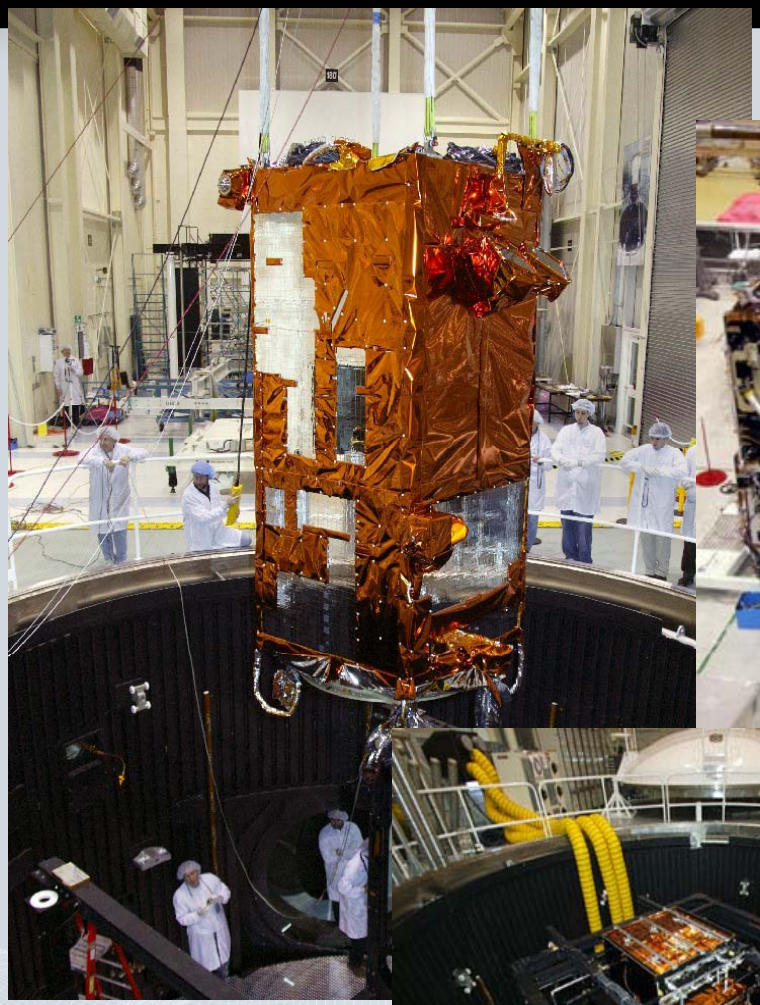
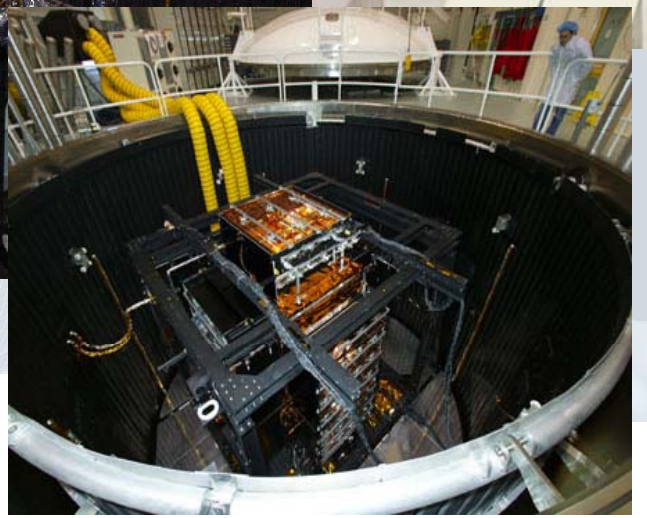
- Appendage Deployments
- Final Integrated System Test
- Operations Validation
- Pack & Ship to Launch Site
- Launch
- S/C Operational





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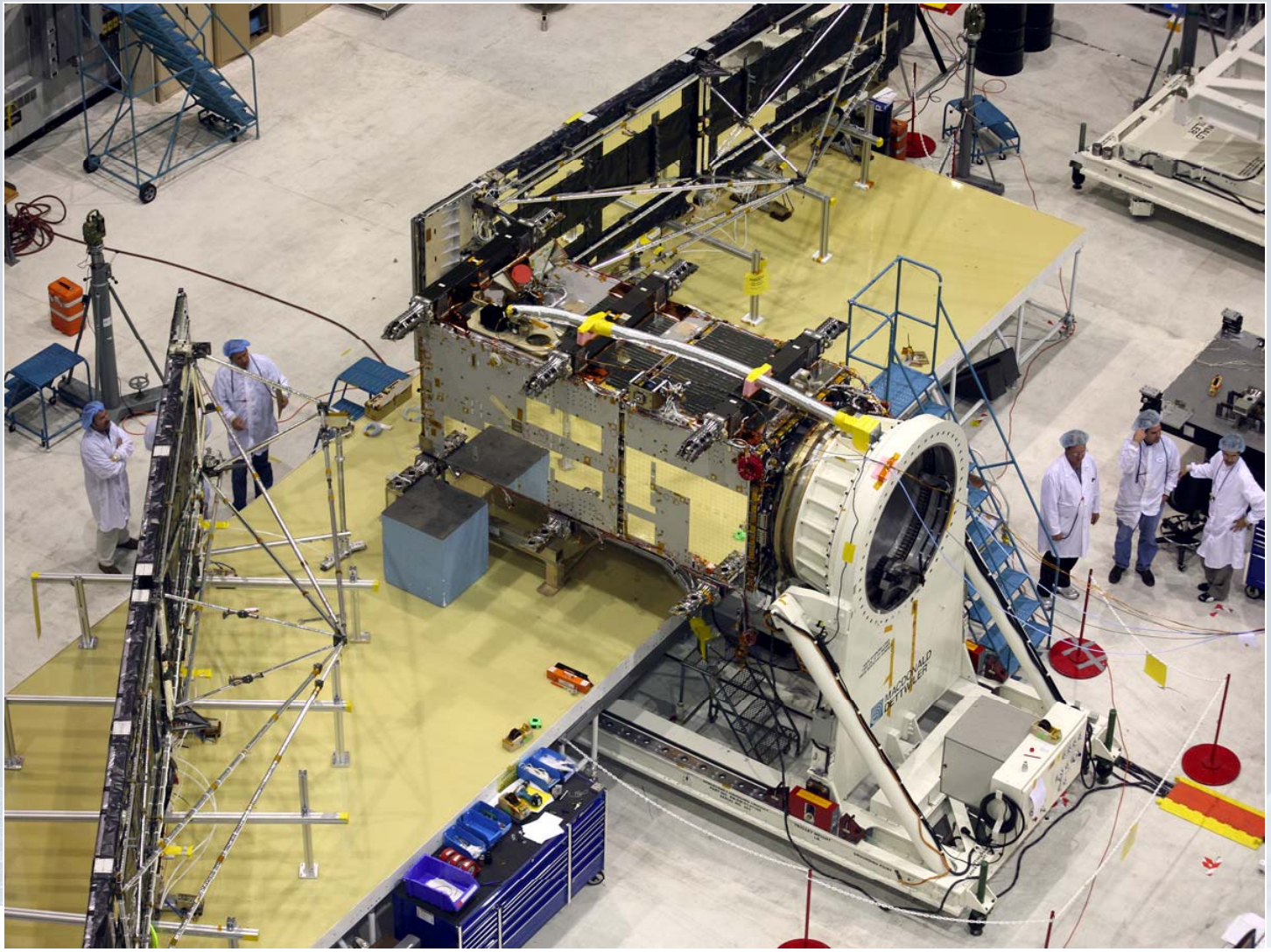

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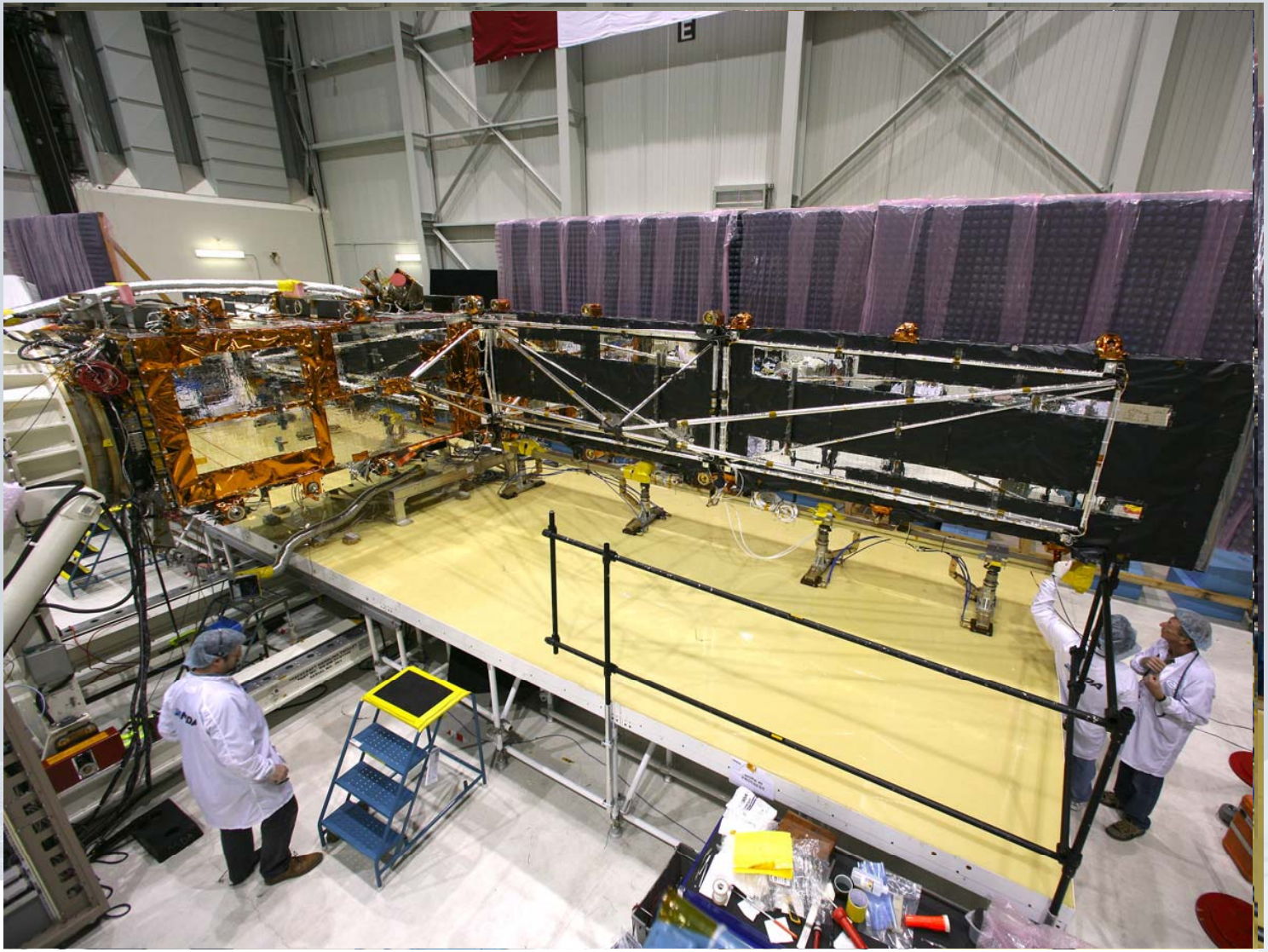

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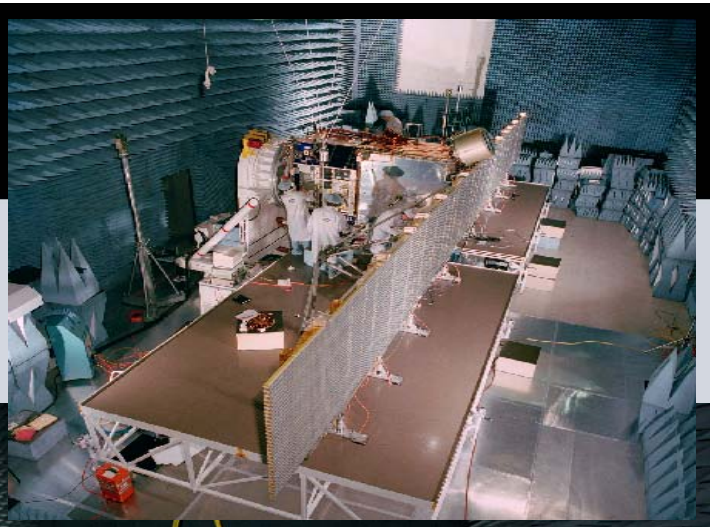

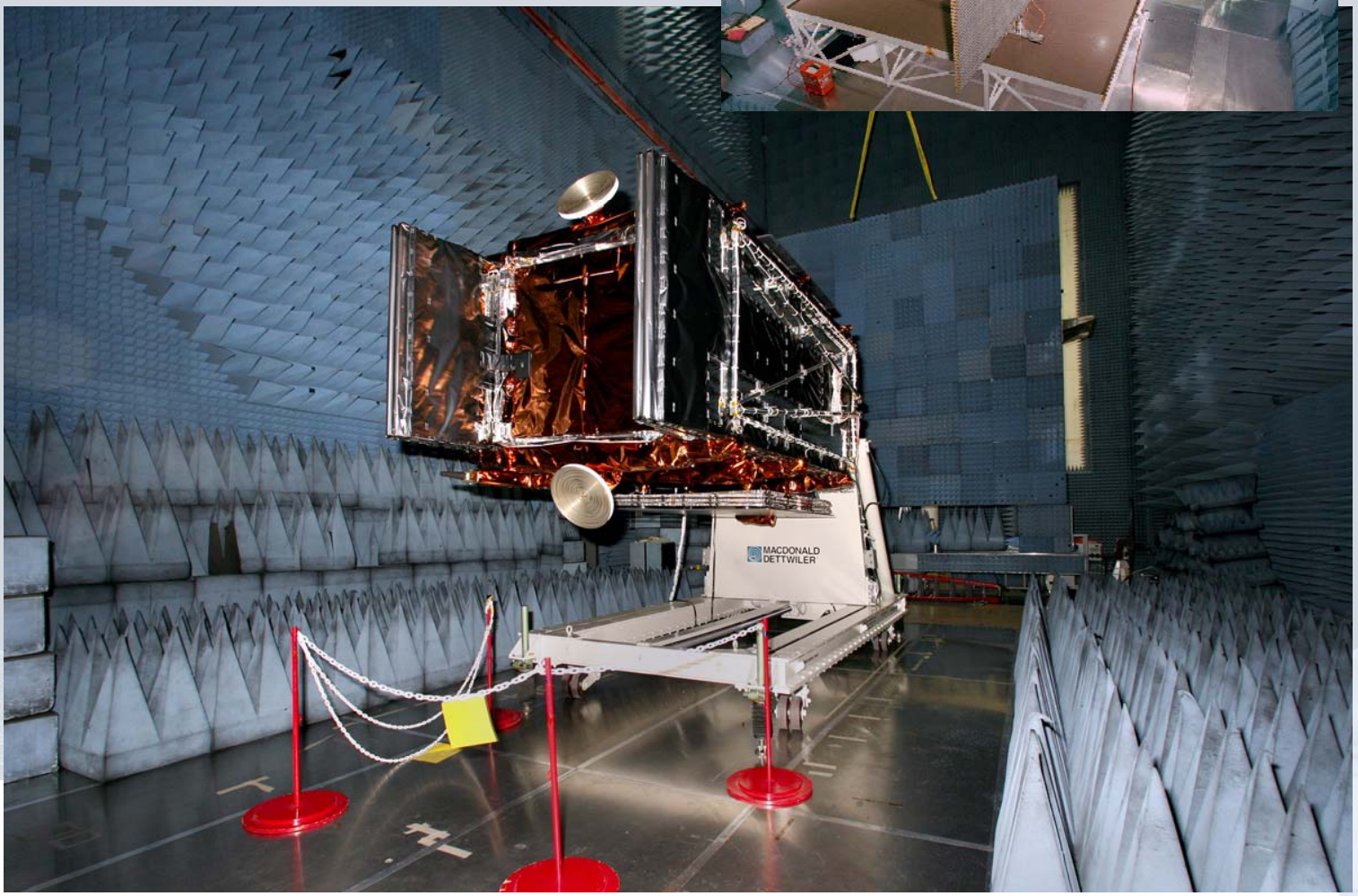

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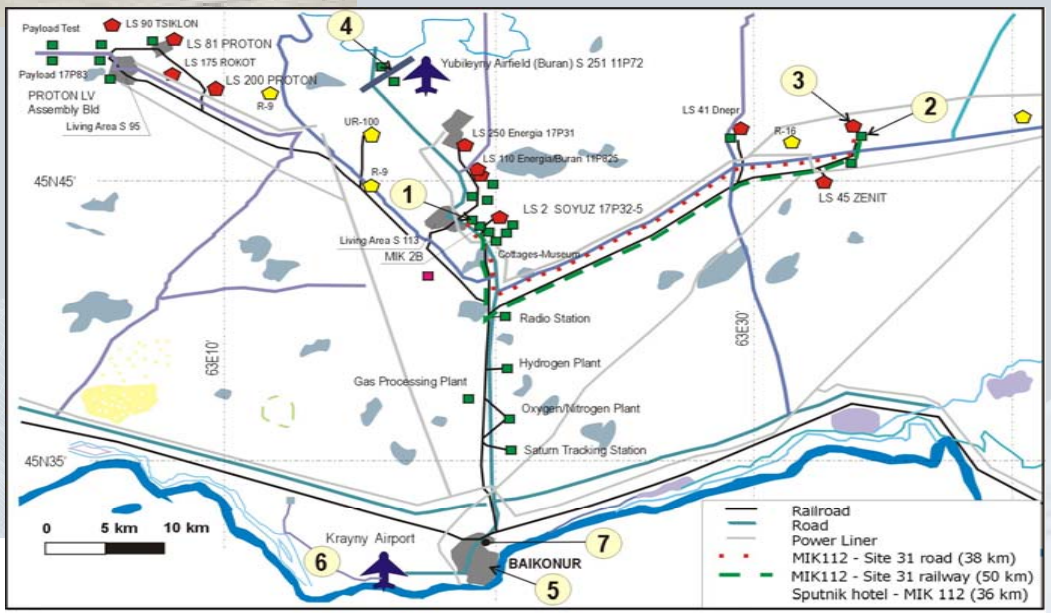

1 Site 112 – STARSEM Payload Processing Facilities
2 Site 31 – MIK40: Launch vehicle assembly hall
3 Site 31 – Launch Pad # 6 and associated facilities
4 Yubileyny airport
5 Baikonur city
6 Krayny airport
7 Sputnik hotel

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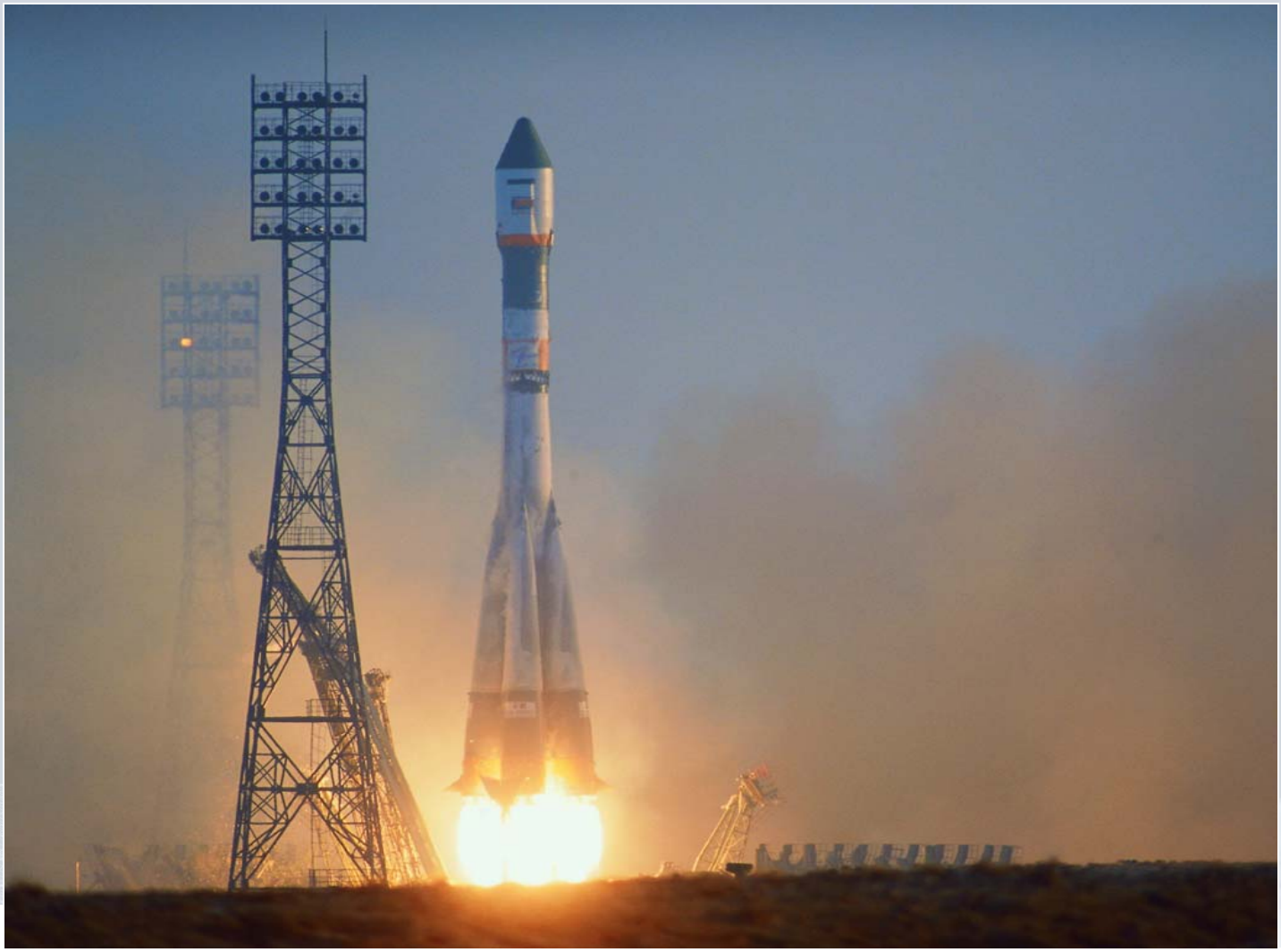
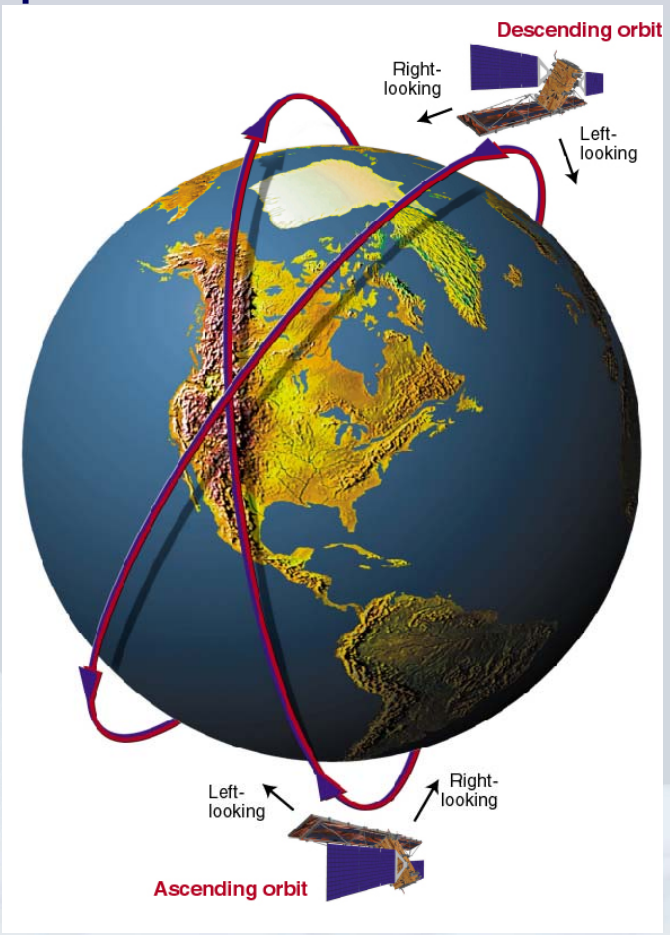


Orbit Parameters

RADARSAT-2 will operate in an orbit identical as RADARSAT-1 except for a 180º offset in time

ORBIT CHARACTERISTICS	
Altitude (average)	798 km
Inclination	98.6 degrees
Period	100.7 minutes
Ascending node	18 hrs (± 15 min)
Sun-synchronous	14 orbits per day
Repeat cycle	24 days

COVERAGE ACCESS USING 500 KM SWATH WIDTH	
North of 70°	Daily
North of 48°	Every 1-2 days
Equator	Every 2-3 days



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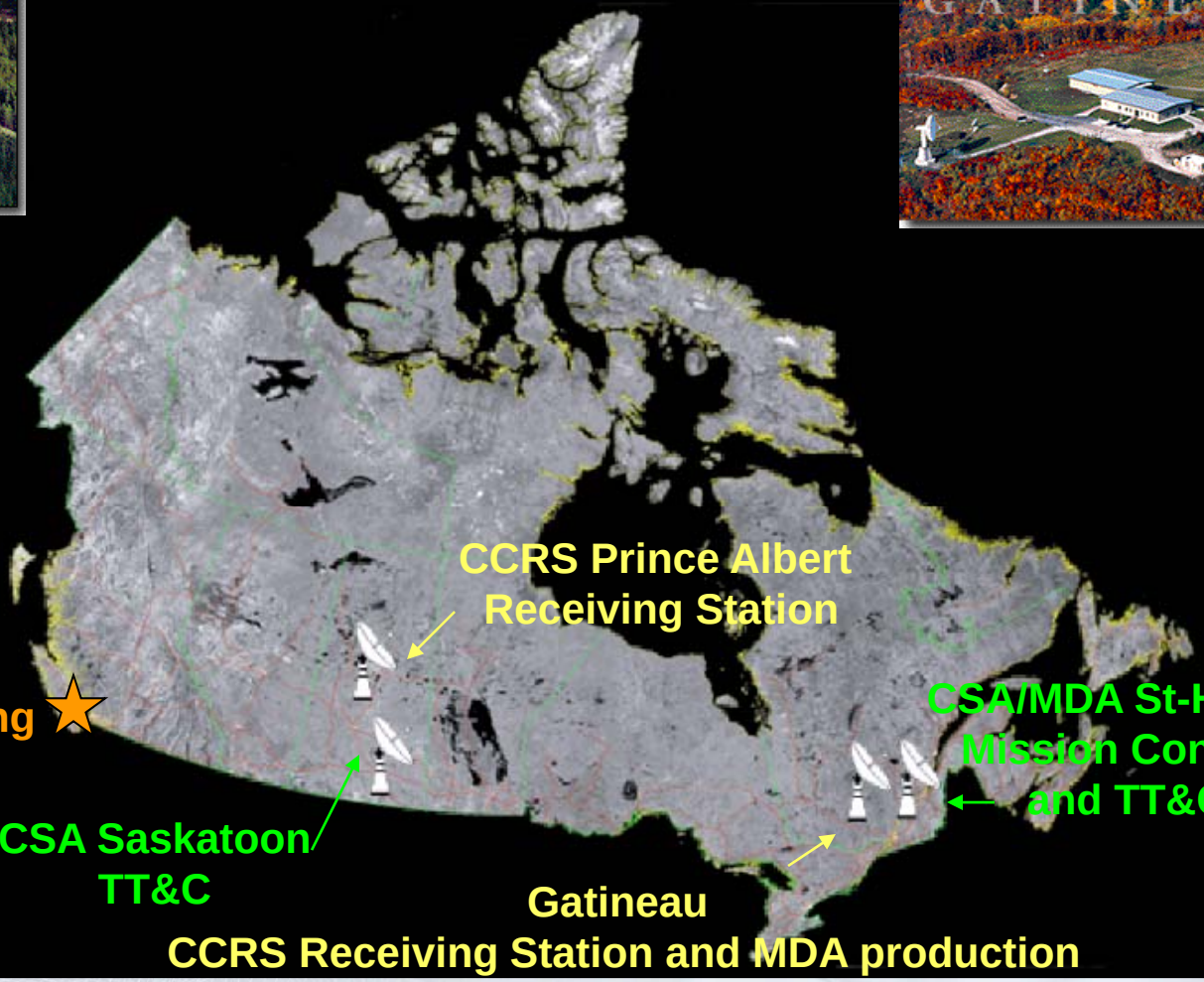
Canadian Ground Segment Locations



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Thank You !

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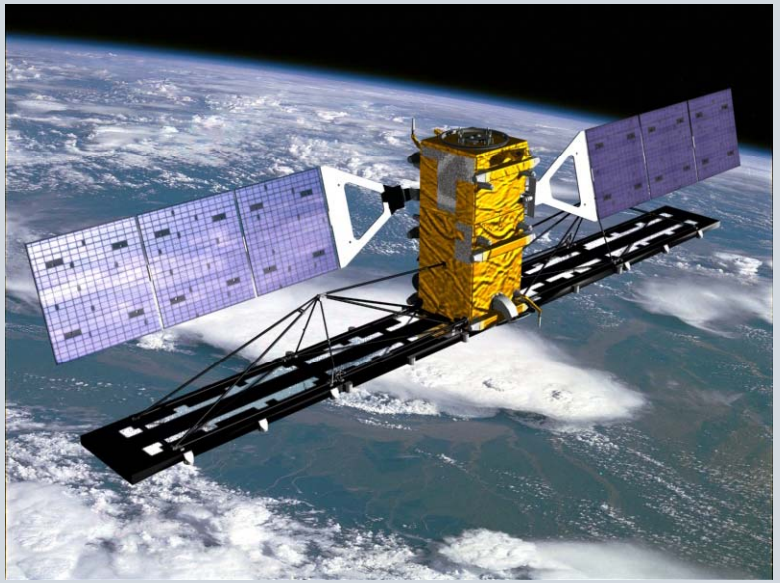
URL: www.mdacorporation.com/geospatial



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